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# MEASURES OF INPUT AND OUTPUT REQUIRED FOR DETERMINING LABOUR PRODUCTIVITY INDICATORS IN INDUSTRY

(Item 9 of the provisional agenda)

Note by the United Nations Statistical Office

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## The concept of productivity

1. Statisticians in many countries are engaged in the compilation of productivity indicators with a wide variety of sophistication and detail. In fact, there are some type of productivity indicators available for more than fifty-five countries (of which the majority are developed countries), without mentioning the work of international organizations. It is also true that despite the attention paid to productivity over the years, confusion still prevails as to its meaning and measurement, but this is understandable because the concept does lend itself to ambiguity and a wide range of productivity measures can and have been developed in response to different analytical uses.

2. Productivity is loosely interpreted to be the efficiency with which output is produced by the resources utilized and it is compiled as a ratio relating output to one or more inputs associated with that output.

3. In the generally accepted definition, productivity means the relationship between the amount of goods and services that came out of an economic unit and the amount of all resources that went into producing them.

4. The output of goods and services may refer to the total output in the economy, that is, Gross National Product or Material Product; or the output of a particular industry such as agriculture, mining, manufacturing, etc.; or to the output of a particular branch of activity: metal mining,

textile industry, etc. or, at the industry or establishment level, to the physical output of a selected commodity such as meters of cotton fabric, tons of steel or number of motor vehicles. Therefore, the productivity measure will reflect the efficiency in the use of the resources at each of the levels of aggregation of that output in a particular country at a particular time.

5. In the other side of the relationship, it is necessary to measure output per unit of all resources, that is, capital, materials etc. and labour. So, in principle, it is possible to conceive measures of productivity per unit of all resources, "total productivity" (sometimes a combination of labour and capital input is used and the measure is called "total factor input"); per unit of capital, "capital productivity" which is often expressed in the form of a capital/output ratio; per unit of materials, etc. that are also compiled as technical co-efficients for particular industries or particular industrial processes (in the aluminum industry, for example, output per kWh is a very useful indicator); and finally, per unit of labour.

Labour productivity

6. The most commonly used measure of productivity relates the total output of goods and services in the economy to the man-hours of all persons engaged in the production of those goods and services. In other words, a measure of real output of the economy per unit of labour input, termed a "labour productivity" measure.

7. Because of statistical limitations it is impossible to construct a precise measure of labour productivity, so it will be necessary to approximate the reality and the measure should only be interpreted as a general indicator of movements of output per unit of labour input. The method of approximating would depend, among other things, on the use to which the measure will be put. A labour productivity indicator is a rough measure of the effectiveness with which the most important productive resource, labour, is used. It has also economic significance. If all terms are consistently defined, if labour compensation per hour rises at the same percentage rate as productivity, then unit labour costs will be stable; and if the shares of compensation in the national income remain unchanged, then prices on the average will be stable. In fact, in market economies developed countries, the price level generally moves very closely with the ratio of compensation per hour to labour productivity per hour (except for cyclical or other short term interruptions). Finally, estimates of labour productivity defined in this simple way will be available to permit comparisons over time and among countries, whereas more sophisticated measures are not.

Labour productivity in industry

8. The simplest definition of an indicator of labour productivity in industry is that it provides a measure of real output in industry per unit of labour input.

9. Industry is defined as including all establishments within the territorial boundaries of the country engaged primarily in mining, manufacturing and the production and distribution of electricity, gas and water. These activities correspond to major divisions 2, 3 and 4, respectively, of the International Standard Industrial Classification of All Economic Activities (ISIC).

10. There are a number of possible labour productivity measures depending on the definitions of the output and input used. The output of goods and services may refer, as mentioned before in the context of productivity in general, to the contribution of industry to the GDP in constant prices or to the "census value added" or to the value of output, net or gross. For particular industries, the output may refer to physical quantities of a commodity produced or a given composite of products.

11. The input of labour may refer to the man-hours worked or paid for by all persons engaged, including proprietors, unpaid family workers and employees, to the man-hours worked or paid for to all employees or it may be limited to the number of man-hours worked or paid for to workers or operatives. In some cases, in addition to or in the absence of reliable information on man-hours, the numbers of employees or operatives are used instead.

12. The various measures of output and input have, of course, some limitations that should at least be mentioned here briefly. (Problems and limitations of the data are discussed later in more detail.) On the output

side, apart from limitations in the scope and coverage of the survey which are equally applicable to the input data, there are consequences of industrial activity that do not pass through a market and are not reflected in existing measures of output. An outstanding example is the deterioration or improvement of the environment which is not counted as deduction from or addition to the product. On the other hand, it should be recognized that different kinds of labour, distinguished by skill, have different productivities.

13. While a measure of labour productivity tells how many hours were consumed or how labour was used in producing the output, it tells nothing about the effort, skill, experience, health, age or sex of the individuals engaged in that production; nothing, of course, about the appropriateness, sophistication, capacity-usage or condition of the capital equipment to which the labour was applied; nothing about how well operations were planned and scheduled and nothing about any of the many other interacting factors that affect productivity.

14. For some users of productivity statistics, labour productivity is an indication of how productive workers are but, in fact, the true meaning of the indicator consists in measuring how productively labour was used. As a matter of fact, an establishment's labour productivity index, can change sharply in either direction as a result of a management change.

Output and input indicators

15. As discussed in previous paragraphs, there are a number of labour productivity measures depending on the purposes for which the indicator is intended, the definitions of output and input used and last, but not least, the availability of the statistical data required.

16. Since productivity measures are mostly constructed from industrial data, the availability of industrial statistics becomes, particularly in the case of the majority of developing countries, the major and sometimes the decisive factor in selecting the types of input and output that should be considered for the compilation of labour productivity indicators. For these countries, the problem is not much the kind of indicator that is best but rather the type of measure that is feasible to be calculated given the input and output indicators that are currently available.

a. Output indicators.

17. Common indicators of output are the contribution of industry to the GDP, the "census value added" in industry, the gross or net value of production of industry, indexes of quantum of production and quantities of selected commodities produced. In order to eliminate price differentials, the value indicators should be in constant prices.

18. The contribution to GDP is the value in the market, generally at producers' prices, of all commodities produced by industry during a period of account, including work in progress and products for own use, less the

purchasers' value of the intermediate consumption. In general, contribution of industry to GDP is available annually for some 110 countries and the level of detail varies from total industry only to total mining, selected groupings of manufacturing activity and total electricity, gas etc.

19. The "census value added" is the value of output less the cost of materials and industrial services used. Value of output includes, according to the internationally recommended definition, the value of all products shipped, the receipts for contract and commission work, the receipts for repair and installation work and other receipts for industrial services as well as the sales of goods in the same condition, the value of fixed assets produced for own account and an adjustment for changes in stocks of finished goods and work in progress. The valuation of output is generally in producers' prices, including all duties and taxes which fall on products. Any subsidies received are excluded.

20. "Census value added" and gross value of production (value of output) are generally available in countries where a system of current industrial surveys is operational and/or a census of industry is conducted. In the case of developing countries, data are available in greater detail, usually at the group level of ISIC (or at a comparable level) for some 60-65 countries. In addition, limited data (only for total manufacturing, for a few selected industries, for only 2-3 recent years or for years well out of date) are also available for some 20-25 countries.

21. Indexes of industrial production are compiled by some 73 countries, of which 32 are developed countries, both market and centrally planned economies, and 41 correspond to developing countries. The indexes usually indicate trends in value added in constant value and are weighted arithmetic means. For countries with market economies, the estimates of value added used for weighting purposes are derived, in most cases, from the results of industrial censuses or comprehensive surveys. The indexes are generally compiled using quantity data on physical output and/or value of output adjusted for price change. Indexes are usually available at the 2, 3 or 4-digit level of ISIC (or comparable levels) for most countries annually and for some countries, quarterly or monthly also.

22. Although quantities of selected commodities produced are available for almost all countries with varying degree of detail, construction of productivity measures are generally restricted in developing countries for lack of corresponding indicators of labour input at the commodity level, except in the case of highly specialized industries.

b. Input indicators

23. A number of labour input indicators are commonly available for constructing measures of productivity. Among them: number of persons engaged, number of employees, number of operatives or production workers and the number of hours worked or paid for by each or some of the occupational groups. Employment indexes for some of the categories are also usually available in a number of countries.

24. According to international standards, persons engaged are defined as the total number of persons who worked in or for the establishment during the reference period, except homeworkers, including working proprietors, active business partners, unpaid family workers and regular employees.

25. Employees are all persons who received pay for work done for the establishment, whether engaged full-time or part-time, including persons on sick leave, holiday or vacation. Also included are salaried manage and directors. The employee concept should, if possible, distinguish between operatives and other employees. The purpose of the subdivision is to identify those employees most directly associated with the production, as opposed to the overhead activities.

26. Operatives are therefore defined as all employees who are directly engaged in the production or related activities of the establishment, including any clerical or working supervisory personnel.

27. Hours worked is defined as the total number of hours actually spent at work, including waiting time. Overtime should be included and calculated in terms of actual hours spent at work and not in terms of time paid for.

28. When the concept used is hours paid for, time spent on vacation, holidays, casual or sick leave when the employee is not at the establishment, should be included.

29. Although numbers of persons engaged, employees and/or operatives are available for the majority of countries reporting to the United Nations Statistical Office (some 100 countries) on an annual basis for publication of the Yearbook of Industrial Statistics, only 32 countries (of which, 14 developing) report hours worked by operatives. In a number of cases, however, the data only refer to a few years and the quality of the data may be questionable.

Practical problems and limitations in developing countries

30. In most developing countries, labour productivity statistics have not been organized in a systematic and consistent way. With very few exceptions, the quality and availability of indicators have, so far, prevented the construction of reliable measures of productivity. Isolated initiatives are confined to restricted groups, mostly analysts and researchers, but the concept has yet to be regarded by the Government and general public, as a useful tool for social and economic analysis.

31. By considering the application of the "ideal" definition of labour productivity in industry, that is, the output of goods and services per hour worked of all persons engaged in the production of those goods and services; it is obvious that a number of problems will arise in practice.

32. The total output of goods and services, in terms of the contribution of industry to GDP, is generally available but only at the aggregate level (total mining, total manufacturing and maybe selected groupings). If GDP were to be used, availability of corresponding labour input indicators, may constitute the main problem. Also, national accounts figures contain an element of estimation that may not be consistent along the years.

33. "Census value added" and value of gross production, as mentioned before, are generally available at the group or equivalent level of ISIC. There are, however, some limitations that should be mentioned. The figures are the result of industrial surveys conducted every year among establishments usually above a cut-off size limit (5, 10, 20 and 50 persons engaged or employees, are the most common establishment size limits) so, depending on the importance of industrial activity by small scale industry, handicrafts and households, that is, the part that is not included in the annual industrial survey, the coverage of the output would be correspondingly reduced. Of course, if the coverage or the lack of it, is the same for all years, the trend will not be affected.

34. Another important limitation, in the case of a number of developing countries, is that figures from the annual surveys are not always adjusted for non-response. This is a particularly troublesome aspect in view of the fact that changes in the year to year coverage do not follow any systematic pattern. However, if the lack of coverage equally applies to the input data, the trend of the productivity ratios will not be substantially affected but the year to year change rate will.

35. Since value added and gross output data should be converted at constant values, there may be a problem in some countries where an appropriate price index is not available, particularly at the group level of industry. National accounts estimates both at current and constant values are, however, normally available in the majority of developing countries.

36. Indexes of industrial production that, as mentioned earlier, are available for some 41 developing countries, offer a clear possibility for their use as indicators of output for constructing productivity measures. From the conceptual point of view, these indexes are indeed equivalent to the net value of output. Provided the indexes have a high degree of "representativeness", the weights are adequate and the base year is moved forward every 5 years or so, the indexes can be used as a reliable indicator in cases where better indicators of output are not easily available.

37. The number of persons engaged in industry is available in a number of developing countries, but the number of hours worked by them is not. Moreover, quite often, the information comes from labour surveys with a different scope and coverage than the industrial survey. If data on persons engaged from the labour survey are to be used, special adjustments should be required.

38. It was mentioned that number of persons engaged, employees and operatives is available for a great number of developing countries in their annual surveys of industry. However, as discussed in connexion with measures of output, the industrial survey usually excludes from its coverage

all establishments below a cut-off size limit. The magnitude of the exclusion in the case of employment is, however, different if compared with the value of output and the resulting productivity indicator would probably have an upward bias.

39. Not only, as repeated before, information on man-hours is not available except for a few countries, but in cases where it is available, the concept refers only to operatives or employees and the annual figures are usually estimates from specified short reference periods during the year. In addition, establishment records may not be adequate for distinguishing hours paid for from the preferred concept of hours worked.

The selection of labour productivity indicators in developing countries

40. From the discussion in preceding paragraphs, it is evident that the compilation of labour productivity measures in developing countries will basically depend on the type of output and labour input indicators available which, in turn, are conditioned to the timeliness and quality of the industrial surveys.

41. In order to illustrate the different alternatives for compilation of labour productivity measures, for which data would normally be available, data for three countries and 12 years at the total manufacturing level have been used to estimate the most commonly accepted ratios. These are: (a) output per man-hour; (b) value added per man-hour; (c) value added per operative; (d) value added per employee; and (e) indexes of production/indexes of employment.

42. Systematic compilation of labour productivity measures in industry can and should be a gradual process in developing countries. In fact, some countries may find it useful to start with the simplest measure and then proceed with the compilation of more complex and sophisticated ones, as soon as more and detailed data become available and experience is gained. With this purpose in mind, it would be useful to study, although on a very limited scale, the way the various measures of labour productivity are related and illustrate how they compare with the "best" or "ideal" concept of output per man-hour. The obvious reason for selecting data for these few countries was expediency: the data were easily available in the UNSO data base and moreover, it is assumed that the results will be, if not strictly applicable, relevant to any developing country in selecting the types of indicators for constructing measures of labour productivity in industry.

43. Primary data for the compilation of the five ratios were available for the Federal Republic of Germany, Sweden and the United States and the results are shown in the following tables. The source of the data is the data file of Volume I of the Yearbook of Industrial Statistics, except for "output per man-hour", which is compiled by the U.S. Bureau of Labour Statistics.

Table 1. Germany, Fed. Rep. of: Indicators of labour productivity in manufacturing

Indexes 1975 = 100

| Year | Output per man-hour | Value added per man-hour | Value added per operative | Value added per employee | Index of production/ index of employment |
|---|---|---|---|---|---|
| | (a) | (b) | (c) | (d) | (e) |
| 1967 | 66.5 | 62.4 | 66.2 | 71.5 | 75.4 |
| 1968 | 71.1 | 66.6 | 72.2 | 78.1 | 80.6 |
| 1969 | 75.4 | 70.4 | 76.5 | 82.8 | 86.2 |
| 1970 | 77.2 | 72.6 | 78.5 | 84.5 | 88.1 |
| 1971 | 80.7 | 76.7 | 81.1 | 86.2 | 89.8 |
| 1972 | 85.6 | 82.3 | 86.1 | 90.5 | 94.8 |
| 1973 | 90.8 | 87.7 | 91.3 | 95.6 | 99.8 |
| 1974 | 96.4 | 93.9 | 95.1 | 98.4 | 100.0 |
| 1975 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| 1976 | 108.2 | 106.3 | 107.7 | 109.8 | 111.3 |
| 1977 | 112.8 | 110.4 | 110.3 | 112.5 | 112.9 |
| 1978 | ... | 115.7 | 114.0 | 115.9 | 115.1 |

Table 2. Sweden: Indicators of labour productivity in manufacturing

Indexes 1975 = 100

| Year | Output per man-hour | Value added per man-hour | Value added per operative | Value added per employee | Index of production/ index of employment |
|---|---|---|---|---|---|
| | (a) | (b) | (c) | (d) | (e) |
| 1967 | 66.5 | 63.8 | 74.6 | 75.9 | 75.6 |
| 1968 | 73.2 | 70.7 | 80.8 | 82.0 | 80.9 |
| 1969 | 78.7 | 76.0 | 84.8 | 86.0 | 85.4 |
| 1970 | 82.8 | 78.9 | 87.8 | 88.8 | 88.8 |
| 1971 | 85.8 | 85.7 | 93.3 | 93.7 | 91.4 |
| 1972 | 91.7 | 92.1 | 97.3 | 97.4 | 94.4 |
| 1973 | 98.0 | 97.3 | 100.2 | 101.1 | 99.8 |
| 1974 | 101.0 | 98.6 | 100.6 | 101.5 | 102.0 |
| 1975 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| 1976 | 101.7 | 103.3 | 101.1 | 100.5 | 99.4 |
| 1977 | 104.1 | 105.2 | 102.1 | 100.5 | 97.5 |
| 1978 | ... | 111.2 | 105.7 | 103.4 | 100.2 |

**Table 3. Unites States: Indicators of labour productivity in manufacturing**

**Indexes 1975 = 100**

| Year | Output per man-hour | Value added per man-hour | Value added per operative | Value added per employee | Index of production/ index of employment |
|---|---|---|---|---|---|
| | (a) | (b) | (c) | (d) | (e) |
| 1967 | 84.2 | 74.5 | 77.5 | 80.0 | 79.0 |
| 1968 | 87.5 | 77.4 | 80.9 | 83.2 | 84.1 |
| 1969 | 88.6 | 79.5 | 82.7 | 84.7 | 85.5 |
| 1970 | 88.4 | 80.7 | 83.1 | 84.0 | 85.9 |
| 1971 | 93.2 | 86.4 | 88.5 | 89.4 | 91.6 |
| 1972 | 97.4 | 91.2 | 94.0 | 96.3 | 97.4 |
| 1973 | 100.1 | 96.6 | 99.5 | 102.6 | 101.6 |
| 1974 | 95.1 | 99.6 | 101.4 | 103.5 | 102.2 |
| 1975 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| 1976 | 104.4 | 104.4 | 105.9 | 106.8 | 108.7 |
| 1977 | 107.5 | 107.7 | 110.0 | 110.8 | 110.5 |
| 1978 | 108.0 | 109.7 | 111.3 | 112.4 | 112.7 |

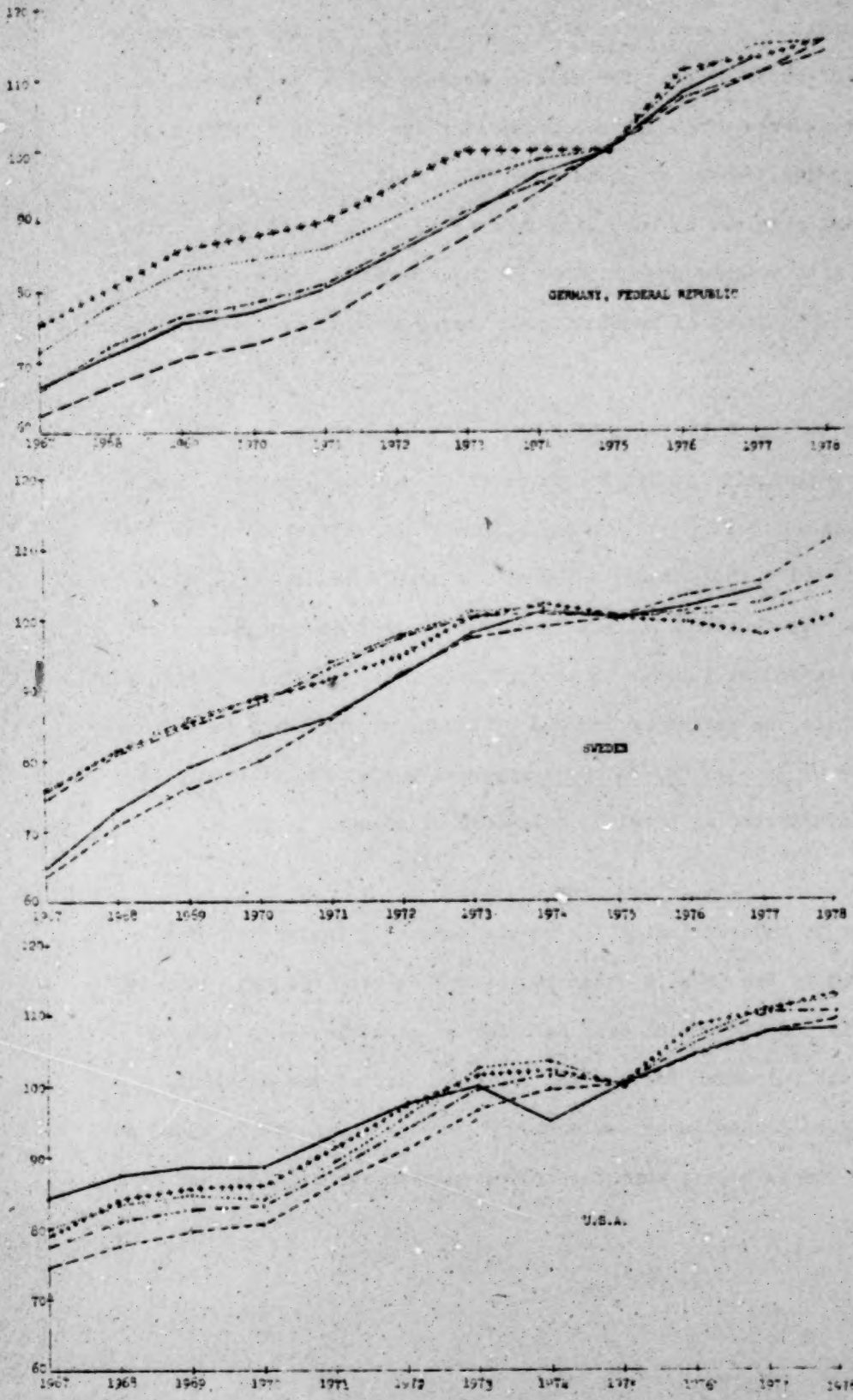
44. In the figure that follows, it can be seen that the trend in each country for the various ratios is quite similar and that there seems to be no great disparities in the year-to-year change between the "output per man-hour" and the other four ratios calculated.

45. A more careful study however, may point out that in general, measures of value added per operative or employee are "closer" to the output per man-hour than the ratio indexes of production/indexes of employment is. No doubt, countries considering the compilation of labour productivity measures should have to study the various alternatives and decide on the one that is best suited according to the needs and availability of data.

The United Nations Statistical Office indexes of labour productivity

46. The Statistical Office of the United Nations has been publishing for some years "indexes of labour productivity in industry" for the world and regions. Apart from the experience in international comparison that this work may have contributed, compilation of these indexes may offer some developing countries an alternative measure of labour productivity that might be considered in the initial stages of a programme in this area.

**Figure 1. Index numbers of labour productivity in manufacturing**




(a) Output per man-hour
(b) Value added per man-hour
(c) Value added per operative
(d) Value added per employee
(e) Index of production/ Index of employment

47. The indexes of labour productivity for ISIC divisions, major groups, or combination of major groups, for each geographic region are calculated by dividing the indexes of industrial production for the region concerned by the corresponding indexes of industrial employment. The regional and world indexes are obtained by combining individual country and geographic region indexes with weights proportional to the number of persons engaged in each division, major group or combination of major groups for the particular region.

48. Missing values are estimated at the country level in both the production and employment indexes for purposes of regional or world totals, assuming that the national trend for a particular activity follows the trend of the region to which the country belongs. It should be noted, however, that it has not been feasible, in all instances, to obtain consistency of scope and coverage in the indexes of production and the indexes of employment. Consequently, while the series of indexes of labour productivity in industry published in the UN Statistical Yearbook may have useful applications, they should not be interpreted as precise indicators of changes in labour productivity.

49. In order to have an indication on the degree of "nearness" of the indexes published by the UN with other indicators in each country, 1968-1977 data available in the industrial data base for 48 countries were used to compile any possible indexes (output per employee, output per man-hour worked, value added per employee, value added per operative, value added per man-hour). All these indexes were then compared with the ones derived from

the relation: indexes of production/indexes of employment. A summary of the results of the comparison follows:

| Correlation coefficient between indexes of production/employment and other indexes of labour productivity | Number of countries compared | Estimated contribution to the world total industrial production (percentages) | Share in the world total industrial employment (percentages) |
|---|---|---|---|
| 0.90 or higher | 29 | 83.6 | 64.5 |
| 0.80 - 0.89 | 4 | 0.3 | 0.5 |
| 0.70 - 0.79 | 2 | 0.9 | 0.9 |
| 0.60 - 0.69 | 3 | 0.1 | 0.2 |
| lower than 0.60 | 10 | 2.2 | 3.8 |
| | 48 | 87.1 | 69.9 |

50. It is of no surprise that the group of countries which contribute 84 per cent to the total world industrial production are included in the first interval, that is, each with a correlation coefficient between 0.9 and 1.0. On the other hand, less developed countries that, in many instances are also characterized by the lack of reliable statistics, are in the other extreme. One common problem, for these countries in particular, is the differences in scope and coverage between the production and employment estimates and the rather poor quality, in general, of their employment estimates. It is

reassuring, however, to know that for purposes of international comparisons, a large error in estimating indicators for the less developed countries may only have a small effect on the totals. For the 48 countries included in the exercise, even though the number of countries with a questionable level of correlation (below 0.7, for instance) represents 27 per cent of the sample, a large error in their estimates would not influence in more than 3 per cent the world estimates. This percentage is probably within the tolerance limits expected for this type of indicators.

51. For the 29 countries in the first interval, variations in year-to-year percentage changes were calculated and graphs drafted for each country. Although the distance between the curves (particularly in the last 2-3 years of the period) may tend to increase in some countries, the trend is, however, always in the same direction. Moreover, large ups and downs in the other curves appear generally to be smoothened in the case of the index of production/index of employment ratios.

52. What is reassuring for international comparisons, unfortunately, is not valid for developing countries in the process of constructing their labour productivity measures. For these countries, improvements in basic industrial statistics will continue to be the first and essential requisite.

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